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EFFECTS OF WASTE DUMP ON THE QUALITY OF PLANTS CULTIVATED AROUND MPAPE DUMPSITE FCT ABUJA, NIGERIA

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Abstract

This paper is aimed at investigating the uptake of heavy metals by plant, since these plants are being consumed directly by people. The study was conducted within a dumpsite located at Mpape in the Abuja Municipal Area Council, Federal Capital Territory Abuja. Metals are essential for maintaining human health throughout life. Intake of heavy metal contaminated vegetables may pose a risk to the human health. Plants take in minerals from soil media or air through their roots or foliage. Understanding the distribution of some trace metals in some common vegetables and tuber crops is important for establishing baseline concentrations from which anthropogenic effects can be measured. The trace metal distribution in some selected vegetables and tuber crop cultivated around Mpape Dumpsite were determined. All the parameters investigated were found present in the three plants species analysed. The concentrations of heavy metals in all the samples cultivated around the dumpsite were higher than those from the control site and they are also above the FEPA limit except Iron and Zinc in spinach that was within the limit. It is important to educate the farmers on the best farming practice and regular monitoring of heavy metal contamination should be encouraged in order to avoid possible consumption of contaminated vegetables.

Key words: Waste dump, Heavy metals, Quality, up-take, Vegetables, Tuber crops.

Introduction

Vegetables are rich sources of vitamins, minerals, trace elements, fibres and also have beneficial antioxidant activities. They constitute an important part of the human diet. Heavy metal contamination of the food items is one of the most important aspects of food quality assurance ((Das, 1990); Wang, *et al.*, 2005; Radwan and Salma, 2006; and Khan *et al.*, 2008). Heavy metals are known to pose a variety of health risks such as cancer, mutations, or miscarriages (Weigert, 1991). They are ranked high amongst the chief contaminants of leafy vegetables (Mapanda *et al.*, 2005). Due to their toxic and mutagenic effects even at very low concentration, they are given special attention throughout the globe.

The problem of solid waste is not just that of generation nor collection but also that of disposal and its effects on the quality of soils and plants. The open dumping of solid waste apart from being unsanitary and unaesthetic creates breeding space for rodents, flies, mosquitoes and other disease carrying vectors. Open waste dumping, among other methods of

solid waste disposal constitute serious problems and health risk, (Magaji, 2005). Most of such disposal sites are not scientifically selected nor well planned, or properly managed so they are usually accessible to scavengers, animals, and vegetable cultivators.

Soil is usually the mostly polluted part of the ecosystem around dumpsites because the seepage of water through the waste dump leaches out undesirable components that pollute it as the main medium of transporting and distributing chemicals elements. Contaminants like heavy metals, acid mine, cyanides, radioactive substance and industrial chemicals are substance that are not only dangerous in themselves but can greatly react in a way that their total effects can always be greater than the sum of the effects taken independently with other materials (Fiar *et al.*, 1968). These adverse impacts of dumpsites include: threat to public health, production of methane through the decomposition of organic matters, and toxicity to plants. Illegal roadside dumping and litter near landfill, dust and windblown litters, odors, multiplication of

vectors such as insects, rodents and birds are inclusive (Lee *et al.*, 1994).

The implication associated with heavy metal contamination is of great concern, particularly in agricultural production systems. These metals can pose a significant health risk to humans, particularly in elevated concentrations above the very low body requirements (Gupta and Gupta, 1988). Heavy metals, in general are not biodegradable, have long biological half-lives and have the potential for accumulation in the different body organs leading to unwanted side effects (Jarup, 2003, and Sathawara *et al.*, 2004.). Among the heavy metals copper (Cu) is an essential element but excess exposure can cause hepatic and kidney damage, haemolytic anaemia and methanoglobinemia (Chugh *et al.*, 1975). High concentration of cadmium exerts detrimental effects on human health and causes severe diseases such as tubular growth, kidney damage, cancer, diarrhea and incurable vomiting (Abbas *et al.*, 2010). The concentration of lead if exceeding the maximum permissible limits in human affects nervous system, bones, liver, pancreases, teeth and gum and also causes blood diseases (Abbas *et al.*, 2010). Chromium VI causes skin rashes, stomach upset and ulcers, respiratory problems, weakened immune systems, kidney and liver damage, alteration of genetic material and lung cancer (Avena, 1979).

It is very alarming today, considering the nature and composition of waste we generate that little attention is given to the proper treatment and care of the disposal sites. Municipal solid waste not only contains 'valuable' and often re-usable materials (such as glass, paper, plastic and food remains) but also contains increasing amount of hazardous substances (Biwas, 1989). Typical of the latter is mercury from batteries, cadmium from fluorescent tubes, pesticides and bleaches as well as a wide range of toxic chemicals such as solvents, paints, disinfectants and wood preservations.

It is obvious that solid waste problem has become a number one serious environmental problem facing the country, because of its consequent effects on the pollution of soil, water and air. Heavy metals toxicity can result in damaged or reduced mental and central

nervous function, lower energy level and damage to blood composition, lungs, kidney, liver and other neurological organs among others (Magaji, 2010).

Various studies have been conducted to evaluate the heavy metal uptake by plants in relation to soil pollution and atmospheric deposition on the surface of soils (Haghiri (1973), Institute for Soil Fertility (1988), Muller and Anke (1994), Ward and Savage (1994), and Voutsas, (1996). Variable results are reported. Larsen *et al.* (1992) found elevated concentrations of Cr and As in soils and plants around a wood preservation factory in Denmark. Around a Cadmium (Cd) processing factory in Germany, very high Cd levels were found in soils and in the banks of the Grumbach brook, which resulted in very high Cd levels in lettuce, onions, and parsley that exceeded the limit values. In contrast, Ward and Savage observed no high values of trace metals in crops located near a superhighway in London, despite the fact that the (Lead) Pb content of the surface soil was significantly increased.

Therefore it is important to publicise the effect of heavy metals on humans and so as to take protective measure against excessive exposure. It has been documented in literature by some researches such as Nwankwo (1991) and Jones-lee (1993), that seepage from waste dump is a major source of soil pollution. It must be collected and treated before allowing it to flow on the ground surface.

The Mpape dumpsite is filled up and the site is undergoing land reclamation with the view of using it as sorting and recycling site. Due to the fertile nature of the soil, people are cultivating some vegetables and fruit crops around the dumpsite. The dumpsite was said to have polluted the soils with leachates (Magaji, 2010). Bearing in mind the possible impacts of dumpsites on the immediate environment, this study attempts to examine the extent to which crops grown in the area may be contaminated. The objective of this study therefore is to analyze the metal and metalloid concentrations viz: (pH, Salinity, Mercury (Hg), Copper (Cu), Silver, Iron (Fe), Zinc(Zn), and Cadmium (Cd)) in cowpea, spinach and potatoes grown within the dumpsite with special emphasis on their

toxicological implications when compared with that of FEPA acceptable standards.

Materials and Methods

The Mpape dumpsite was selected as the study area. It is located at the Northeastern edge of the Gwagwa plains by the Kubwa expressway near the tipper garage of Mpape, within the watershed of the River Usuma Basin. The Federal Capital Territory (FCT)

Abuja is located between latitudes $8^{\circ} 25'$ and $9^{\circ} 25'$ north of the equator and longitudes $6^{\circ} 45'$ and $7^{\circ} 45'$ east of Greenwich meridian (Figure1). It occupies an area approximately $8,000\text{km}^2$ and occupies about 0.87% of Nigeria. The territory is situated within the region generally referred to as the Middle Belt (Mabogunje, 1977), and is bordered on all sides by four states namely Kogi, Niger, Kaduna, and Nassarawa.

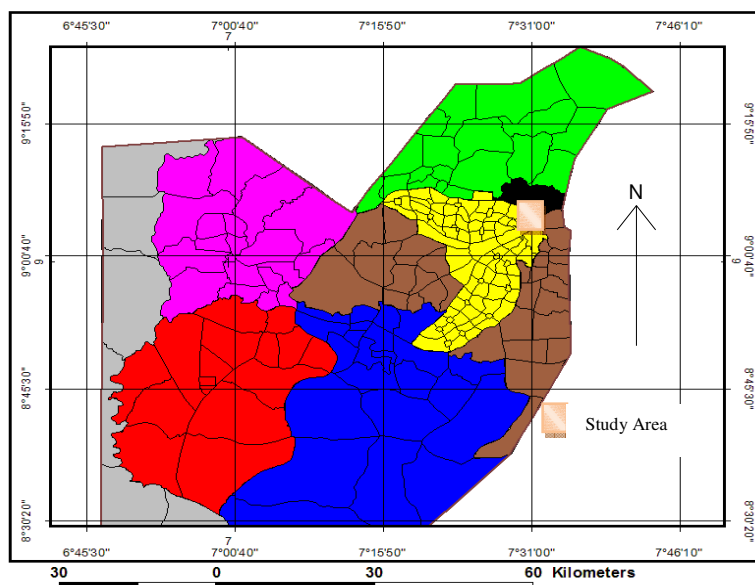


Figure 1 Location of Mpape Dumpsite in the FCT.
Source: Abuja Master plan, (1979)

The Federal Capital consists of a number of distinct physiographic regions basically of two types, the hills and the plains. The elevations of these hills range from about 100m to about 300m in the more rugged areas. The landfill is situated at the upper part of the plains. The influence of parent materials on the soil of FCT stem from the fact that two parent materials, namely, crystalline rocks of the basement complex and Nupe Sandstone are the surface from which they are formed.

The soils of the FCT, for the purpose of easy identification is described along six major land systems, namely, the undulating Gwagwalada plains, the Abuja dissected plains, the Kau plains, the undulating Kuje plains, the Iku and the Robo plains (Alhassan, 2000). The alluvial complexes of the territory are contained in all the stream channels which are made up of gleysols which are very fertile and occur dominantly in Abaji Area Council

of the FCT. The soils of the plains are mostly sandy and sandy-loam. This section of the FCT houses most of the rain fed agricultural activities.

The Federal Capital Territory records the highest temperature during the dry season months, which are generally cloudless. The maximum temperature occurs in the month of March with amounts varying from 37°C in the Southwest to about 30°C in the Northeast. This also coincides with the period of high diurnal ranges of temperature which can drop to as low as 17°C , and by August, diurnal temperature rarely exceeds 7°C .

Sample Collection and preparation

Three common and widely consumed Nigerian crops by urban dwellers grown on the site were collected during the wet season as samples for analysis. These include Spinach, Cowpea and Potatoes grown in the dumpsite were obtained from local farmers

around the dumpsite. Another three plants species were sampled away from the dumpsite to served as the control experiment. The plants were cut into pieces, washed, air dried for one week and then dried in the oven (Gallen Kamp, England). The sample species were powdered in a hammered mill and packaged in a glass bottle ready for analysis. The samples collected were replicated for consistency.

Methods of Laboratory analysis

For the determination of heavy metals contents of Spinach, Cowpea and potatoes samples, the collected samples were homogenized using a heavy duty blender with deionized water. Ten grams (10g) of each sample was weighed using an analytical

balance and dissolved in 100ml of deionized water. The pH of the samples was recorded using Corning pH meter by introducing the meter probe into the prepared samples. The Salinity was measured by introducing the probe of the HACH CO 150 conductivity meter. The concentrations of the heavy metals were determined using the Jenway 3340 ION selective meter.

Results

In this section, the results of the study are presented and discussed.

Table 1 Results of plants analysis within the dumpsite (experimental)

Parameter	Cowpea	Spinach	Potatoes
pH	4.8	5.7	4.9
Salinity	0	0.2	0.3
Mercury (mg/l)	0.047	0.89	0.97
Copper(mg/l)	0.096	0.0203	0.098
Silver (mg/l)	0.03	0.0096	0.03
Iron (mg/l)	0.9	0.017	0.36
Zinc (mg/l)	0.5	0.0286	0.45
Cadmium (mg/l)	4.94	0.045	5.45

Table 1 show that the pH value is 4.8 in cowpea, 4.9 in potatoes and 5.7 in spinach; this implies that the crops are slightly acidic. Salinity is very low rising from 0 in cowpea, 0.2 in spinach, and 0.3 in potatoes. Mercury was found to be 0.047 in cowpea, 0.89mg/l in spinach, and 0.97mg/l in potatoes, the highest concentration occurs in copper which was 0.098mg/l followed by 0.096mg/l in cowpea and the least value of 0.0203mg/l was

recorded in spinach. Silver was found to be 0.03mg/l in cowpea and potatoes, while 0.0096mg/l was recorded in spinach. Iron was found to be 0.9mg/l in cowpea, 0.39mg/l in potatoes and 0.017mg/l in spinach. Zinc was 5mg/l, 0.045mg/l, and 0.0286mg/l, in potatoes, cowpea and spinach respectively. Cadmium was 5.45mg/l in potatoes, 4.94mg/l in cowpea, and 0.045mg/l in spinach.

Table 2 Results of analysis of the concentrations of heavy metals in plants from the control site.

Parameter	Cowpea	Spinach	Potatoes
pH	7.3	6.8	6.9
Salinity	0	0	0
Mercury(mg/l)	0.013	0.006	0.005
Copper (mg/l)	0.011	0.0075	0.014
Silver (mg/l)	0.006	0.00034	0.005
Iron (mg/l)	0.25	0.26	0.27
Zinc (mg/l)	0.06	0.003	0.044
Cadmium (mg/l)	0.004	0.002	0.031

Table 2 shows that the pH value in the control plants samples was 7.3 in cowpea, 6.9 in potatoes and 6.8 in spinach; this implies that the crops pH is almost neutral. Salinity is 0 in all the plants samples. Mercury is 0.013mg/l in cowpea, 0.006mg/l in spinach, and 0.005mg/l in potatoes. Copper was found to be 0.011mg/l in cowpea, followed by 0.014mg/l in potatoes and the least value of 0.0075mg/l was recorded in spinach. Silver was 0.006mg/l in

cowpea and 0.005mg/l potatoes, while 0.003mg/l was recorded in spinach. Iron was found to be 0.25mg/l in cowpea; 0.26mg/l in spinach and 0.27mg/l in potatoes. Zinc was 0.06mg/l, 0.003mg/l, and 0.044mg/l, in cowpea, spinach and potatoes respectively. Cadmium was 0.031mg/l in potatoes, 0.004mg/l in cowpea, and 0.002mg/l in spinach.

Table 3 Comparative analysis of the concentration of heavy metals in plants of the control and dumpsite samples.

Parameter	Cowpea Dumpsite	Control	Spinach Dumpsite	Control	Potatoes Dumpsite	Control
Ph	4.8	7.3	5.7	6.8	4.9	6.9
Salinity	0	0	0.2	0	0.3	0
Mercury (mg/l)	0.047	0.013	0.89	0.006	0.97	0.005
Copper(mg/l)	0.096	0.011	0.0203	0.0075	0.098	0.014
Silver(mg/l)	0.03	0.006	0.0096	0.0003	0.03	0.005
Iron(mg/l)	0.9	0.25	0.017	0.26	0.36	0.27
Zinc(mg/l)	0.5	0.06	0.0286	0.003	0.45	0.044
Cadmium(mg/l)	4.94	0.004	0.045	0.002	5.45	0.031

The results of the analysis of heavy metals in plants cultivated within the dumpsite and those from the control site. The pH value of the three samples is higher than those of the dumpsite, implying that the crops planted far from the dumpsite are slightly acidic. Salinity is zero except in spinach and potatoes that is

0.2 and 0.3 respectively away from the dumpsite. The concentration of the heavy metals in all the samples cultivated around the dumpsite is higher than those from the control site. This is a clear indication that the waste dump has affected the quality of the crops grown around the area.

Table 4 Comparative analysis of heavy metals concentration for the dumpsite samples with those of FEPA standard.

Parameter	Cowpea	Spinach	Potatoes	FEPA limit	Remark
pH	4.5	5.9	4.5	6.5-8	Above the limit
Salinity	0.3	0	0.2	NM	
Mercury	0.84	0.017	0.87	0.001	Above the limit
Copper	0.086	0.0103	0.088	0.01	Above the limit
Silver	0.03	0.0096	0.03	NM	
Iron	0.7	0.007	0.3	0.03	Above the limit except in spinach
Zinc	0.4	0.0186	0.4	0.03	Above the limit except in spinach
Cadmium	4.94	0.035	5.24	0.0005	Above the limit

NM= Not Mentioned

Safety limit for salinity and silver were not mentioned. Table 4 indicates that the concentrations of mercury, copper, and cadmium in plants of the dumpsite are above FEPA limit, except spinach that contains Iron and zinc values within the safety limit.

Discussion

This study shows that all the analysed parameters were present in all the three plants samples. The results show that the pH of the plants samples is slightly acidic. The pH of a substance is important because it affects the solubility and availability of nutrients to plants

and how they can be utilized by organisms. It was also revealed that the concentrations of heavy metals in all the samples cultivated around the dumpsite are higher than those from the control site and they are also above the FEPA limit except Iron and Zinc in spinach that is within the limit. Salinity and silver limits were not mentioned. Though the difference is not much, but it should be noted that heavy metals in the body are biocummulative and become toxic when they are not metabolized by the body and accumulate in the soft tissues gradually over time.

Eating food with very high levels of cadmium increases salivation severely irritates the stomach, leading to vomiting and diarrhea. Long term exposure to lower levels of cadmium in food leads to a buildup of cadmium in the kidneys and possible kidney disease. Other potential long term effects are lung damage and fragile bones, abdominal pain, choking and tenesmus. Animals given cadmium in food show high blood pressure, iron-poor blood, liver disease, and nerve or brain damage. The Department of Health and Human Services (DHHS) has determined that cadmium and cadmium compounds may reasonably be anticipated to be carcinogens.

Zinc is an essential element in our diet. Too little zinc can cause health problems, but too much zinc is also harmful. Results revealed that zinc level exceed the safety level, it implies that adequate measures have to be put in place.

Exposures to high levels of metallic, inorganic, or organic mercury can permanently damage the brain, kidneys, and developing fetus. Effects on brain functioning result in irritability, shyness, tremors, changes in vision or hearing, and memory problems. Research has shown by Occupational Safety and Health Administration (OSHA), that exposure to methyl mercury is worse for young children than for adults, because more of it passes into children's brains where it interferes with normal development.

Conclusion and Recommendations

It is essential that the farmers be educated and encouraged to reduce such contamination by controlled use of pesticides waste, not using waste water and cultivating in a field far

away from waste dump areas. The use of natural manure and compost should be encouraged among the farmers because they are harmless. It is suggested that regular monitoring regarding the heavy metal contamination should be encouraged as vegetables are the main sources of food in Nigerian urban areas to avoid possible consumption of contaminated vegetable foodstuffs.

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